Mathemat

3T

A NEW and EASY METHOD To find the LONGITUDE AT *LAND* or *SEA*.

From the Obſervation of the Altitudes of the Cœleſtial Bodies only; without having any Recourſe to Eclipſes, the Satellites of *Jupiter*, the Doctrine of *Appulſes*, or the Magnet; and without the uſe of Clock-work, Dials of any ſort, Sand-Glaſſes or Pendulums; or any other Inſtrument, but a SEXTANT, QUADRANT, or ASTROLABE.

Publiſhed for the Improvement of *Geography* and *Navigation*, and the Univerſal Benefit of Mankind.

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II

3. March.

TO THE READER.

THE *Author of this* ESSAY *having had the Misfortune to loſe his Original Manuſcript above a Year ſince, did again, about two Months paſt, digeſt his Thoughts in the following Order; which now he thinks himſelf obliged to Publiſh in a more haſty manner than otherwiſe he intended to have done; Becauſe that on* Friday *laſt the* 23d *of this Inſtant* June, *he was inform'd, That on* Wedneſday *the* 21ſt *of the ſame Month, Mr.* Keith *had preſented a Paper to the* Royal Society, *at* Greſham *College, about Longitude: And having thereupon procured a ſight of the ſaid Paper, and finding ſome things therein agreeing with ſome of the follow-*

following Notions; The Author hereof did, the ſame Day, viz. *the* 23d *Inſtant, about two Hours after he had ſeen the ſaid Paper, ſhew the Copy, from which the following Sheets are printed* verbatim, *to a Perſon of Great Worth and Learning; who was thereupon pleaſed to peruſe the ſaid Copy, and to ſeal and ſubſcribe the ſame, that no Alteration might be made therein; And the ſame Day the Author gave Order for the Printing It: Which is done, not with deſign to detract from any Merit which may be due to Mr.* Keith's *Performance, but only to prevent the ſaid Mr.* Keith's *entertaining any Thoughts that the Author hereof has borrow'd any thing of him.*

London, *June* 26. 1710.

ADVERTISEMENT.

This ESSAY will very ſpeedily be Publiſh'd in *Latin*, *French* and *Dutch*.

A
New and Eaſy
METHOD
To find the
LONGITUDE
AT
Land or Sea.

IT is now about Nine Years ſince the Author firſt Diſcover'd the following Method of finding the Longitude; which is now made Publick, not only to make good what, in private Converſation, he has often ſaid he could do; But chiefly, as he humbly hopes, for the general Good of Mankind. Whether the Method he propoſes, will obviate the Difficulties,

which

which by many have been thought inſuperable: And whether it be not as truly a Solution of the Queſtion, and founded upon as eaſie Principles, as any Problem in Aſtronomy; and conſequently, as much as our preſent Views of the Nature of things can warrant us to expect or deſire, is humbly ſubmitted to the Determination of the Learned World.

POSTULATUM.

THAT the Altitudes (or Vertical Angles comprehended between any two) of the Cœleſtial Bodies, can be exactly taken at Land or Sea.

HYPOTHESIS I.

WE may, during the time of our Calculations, ſuppoſe the Univerſal Syſtem of Heaven and Earth to ſtand ſtill; or to continue in the ſame Poſition they were in at the Moment of Obſervation.

HYPOTHESIS II.

WE may ſuppoſe the FIRST MERIDIAN to paſs through the CENTER of the SUN, or through any known FIXED STAR, at pleaſure.

DEFI-

DEFINITION I.

THE Longitude of any Place on the Terraqueous Globe, from the Meridian, correſponding to the Firſt Meridian, is meaſured by an Arch of the Equator, comprehended between the Firſt Meridian, and the Meridian which paſſes through the Zenith of the Place.

DEFINITION II.

THE Difference of Longitude between any two Places on the Terraqueous Globe, is meaſured by an Arch of the Equator, comprehended between the two Meridians paſſing through the Zeniths of the reſpective Places.

Theſe Things being premiſed;

> *Suppoſe* Anno 1710. *in the Month of* January, *I obſerve the* Moon *and* Cor Leonis *in the ſame Vertical Plane, and their Diſtances from the Zenith, as follows*, viz.

	°	′	″
The Diſtance of ☽ *from the Zenith*	36	37	19
The Diſtance of Cor Leonis *from the Zenith*	44	59	04
And alſo			
The Diſtance of Cor Hydræ *from the Zenith*	49	16	20

It is required to find,

The Latitude of the Place of Obſervation.

The Longitude of the Place of Obſervation from the Meridian of London.

The Day of the Month, and Hour and Minute of the Obſervation.

Suppoſe the Heavens to be, during the time of our Calculations, in the ſame Poſition they were in at the time of the aforeſaid ſuppoſed Obſervations.

Suppoſe, in this Example, the **FIRST MERIDIAN** to paſs through *Cor Leonis.*

I. *By Mr.* Street's *Catalogue of the fixed Stars,*

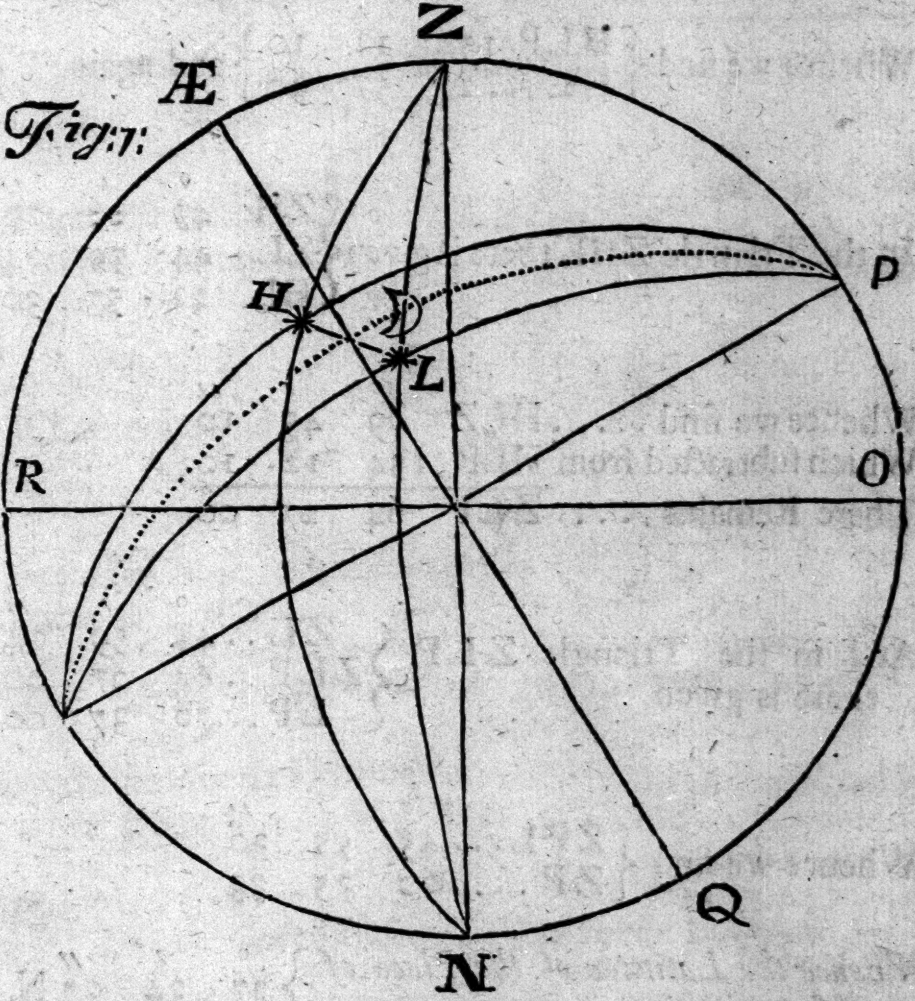
	Cor. Leonis.		Cor. Hydræ.	
	Long. a 1 * ♈	*Lat. N.*	*Lo. a* 1 * ♈	*Lat. S.*
	S. ° ′ ″	° ′ ″	S ° ′ ″	° ′ ″
	3.26.40.00..	0.26.0	3.24.08.00..	22.24.0
Præceſſion of the Equinox, Anno 1710 ineunte	0.29.03.12		0.29.03.12	
Longit. from the Vernal Equinox	4.25.43.12		4.23.11.12	

Whence

Whence by the Doctrine of Spherical Triangles, we find,

	°	′	″
The Right Aſcenſion of *Cor Leonis*	148	08	00
The Declination of *Cor Leonis* ——	13	23	00 N.
The Right Aſcenſion of *Cor Hydræ*	138	16	39
The Declination of *Cor Hydræ*	7	23	00 S.

Fig: 7:



II. In the Scheme; Let Z R N O repreſent the Meridian of the Place of Obſervation; P the North Pole; Æ Q the Equator; Z ☽ L N a Vertical Circle paſſing through the Center of the Moon, and through *Cor Leonis*; and Z H N a Vertical Circle paſſing through *Cor Hydræ*.

Where-

Wherefore in the Triangle HPL, there is given

	°	′	″
HP ..	97	23	00
HPL ..	9	51	21
LP ..	76	37	00

Whence we find

	°	′	″
HLP	154	12	10
HL ...	22	57	30

and again,

In the Triangle ZHL there is given

	°	′	″
ZH	49	16	20
ZL	44	59	04
HL	22	57	30

		°	′	″
Whence we find	HLZ	89	45	10
Which ſubtracted from	HLP	154	12	10
There Remains	ZLP	64	27	00

And in the Triangle ZLP, there is given

	°	′	″
ZL ..	44	59	04
ZLP ..	64	27	00
LP ..	76	37	00

Whence we find

	°	′	″
ZPL ...	45	55	30
ZP	62	35	33

	°	′	″	
Whence the Latitude of the Place of Obſervation is	27	24	27	N.
And the Longitude of the Place of Obſervation from our Firſt Meridian *is*	45	55	30	W.

III. *To*

III. *To find the* Moon's *Right Aſcenſion and Declination.*

	°	′	″
The Diſtance of *Cor Leonis* from the Zenith ZL	44	59	04
The Diſtance of the *Moon* from the Zenith Z☽	36	37	19
Difference L☽..	8	21	45

Therefore in the Triangle LP☽, there is given		°	′	″
	LP	76	37	00
	PL☽	64	27	00
	L☽	8	21	45

Whence we find		°	′	″
	LP☽	7	52	50
	P☽	73	08	14

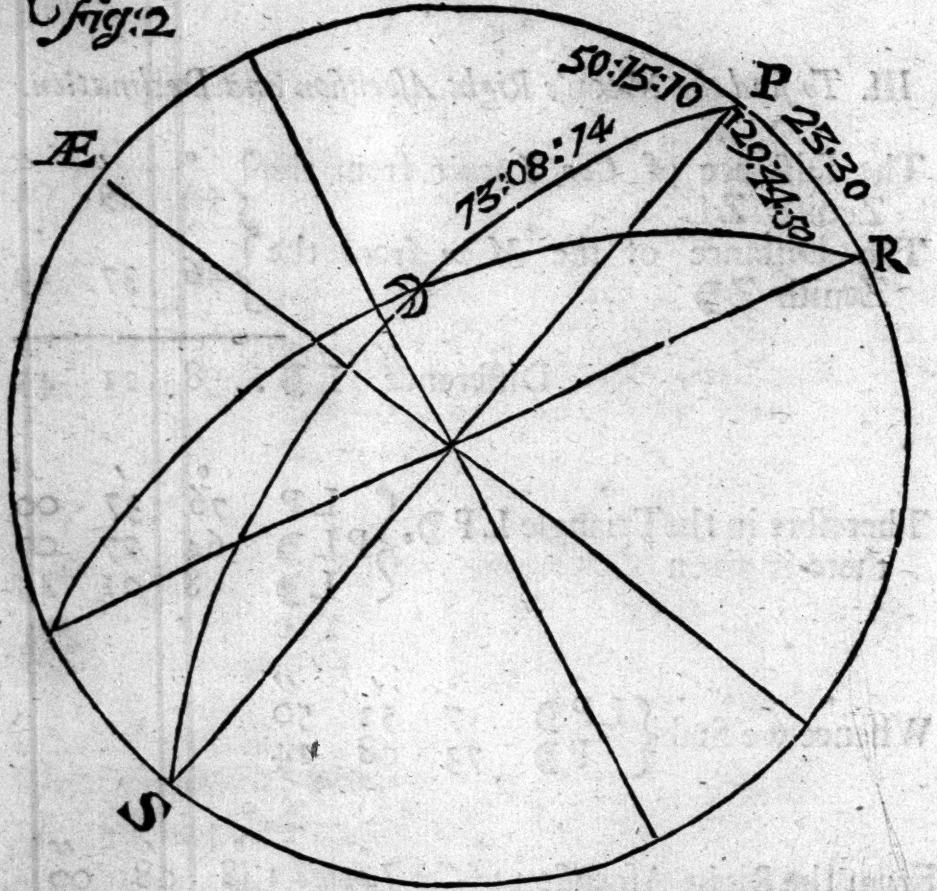
	°	′	″
From the Right Aſcenſion of *Cor Leonis*	148	08	00
Subtract LP☽ — — — —	7	52	50
The Right Aſcenſion of the Moon	140	15	10
And the Moon's Declination equal to the Complement of P☽ to 90° is	16	51	46N

IV. *To find the* Moon's *Place in the Eclip‍tick.*

In the following Scheme, Let PSR repreſent the Solſtitial Colure ; P the Pole of the World ; and R the Pole of the Ecliptick. Then in the Triangle P☽R,

there

Fig:2



there is given RP 23° 30′, the greateſt Obliquity of the Ecliptick; P☽ 73 08 14, the Complement of the Moon's Declination; and the Angle RP☽, the Complement of the Moon's Right Aſcenſion to 270°. *Viz.* 129° 44′ 50″.

		°	′	″
Whence we find	PR☽	47	23	28
	R☽	88	44	00

	°	′	″	
To the Angle PR☽	47	23	28	and the Sum is,
Add — — —	90	00	00	

	s	°	′	″
The Moon's place in the Ecliptick	4	17	23	28

and

		°	′	″	
And from	— —	90	00	00	The Remainder is,
Sub. R ☽	— —	88	44	00	
The Moon's Latitude	— — —	1	16	00 N.	

N. B. The Moon's Place may in like manner be found, by obſerving the Altitudes of any two known Fixed Stars, the *Moon*'s Altitude, and the Vertical Angle comprehended between the *Moon* and either of the ſaid Fixed Stars; which is a more univerſal Method than that before mention'd; but not ſo conveniently to be practiſed at Sea.

V. *To find the* Sun'*s Place in the Ecliptick correſponding to the obſerved Place of the* Moon.

IN the *Ephemerides* calculated for the Meridian of *London*, find the Day of the Month and the Hour and Minute anſwering to the *Moon*'s Place by Obſervation, Thus;

		°	′	″
The *Moon*'s Place by Obſervation	♌	17	23	28
And by the *Ephimerides*,				
An. 1710, *Jan.* 5. at Noon, the ☽ is in	♌	10	00	00
Jan. 6. at Noon, the ☽ is in	♌	24	43	00
The *Moon*'s Diurnal Motion — —		13	17	00

From the *Moon*'s Place by Obſervation ſubtract her Place *January* 5th at Noon; the Remainder is	°	′	″
	7	23	28

Then ſay, $13^{\circ}\ 17'\ 00'' : 24^{\text{hours}} :: 7^{\circ}\ 23'\ 28'' : 13^{\text{hours}}\ 21'$

To the Time thus found by the *Ephemerides*, calculate the true Places of the *Sun* and *Moon*; Thus,

Anno 1710, *January* 5th. $13^{h}\ 21'$ *T. M.*

By the *Caroline Tables* we find,

		°	′	″
The *Sun*'s Place — — —	♑	26	36	47
The *Moon*'s Place — — —	♌	18	13	21
The *Moon*'s Place by Obſervation	♌	17	23	28
Difference		00	49	53
The *Moon*'s Hourly Motion — —		00	35	31

Then ſay,

$35'\ 31'' : 1^{h} :: 49'\ 53'' : 1^{h}\ 24'$

	h	′
From the Time found by the *Ephemerides* *Jan.* 5.	13	21
Subtract — — — — — —	1	24
The Time firſt corrected - - - - - - *Jan.* 5th.	11	57

To

To which Time, find again,

		°	′	″
The *Sun*'s Place — — —	♑	26	33	11
The *Moon*'s Place — — —	♌	17	21	31
The *Moon*'s Place by Obſervation	♌	17	23	28
Difference		00	01	57
The *Moon*'s Hourly Motion — —		00	35	31

Then ſay,

$$35' \; 31'' : 1^{h} :: 1' \; 57'' : 3'$$

		h	′
To the Time firſt corrected	*January* 5th	11	57
Add — — — — — — —			3
The Time 2 corrected - - - - -	*January* 5th	12	00

To the Time 2 corrected *Anno* 1710, *January* the 5th 12 *h.* calculate the Places of the *Sun* and *Moon*, *viz.*

		°	′	″
The *Sun*'s true Place — — —	♑	26	33	19
The *Moon*'s true Place — —	♌	17	23	29
The *Moon*'s Place by Obſervation	♌	17	23	28

The *Moon*'s Place by Calculation and Obſervation agreeing; Note the correſponding Place of the *Sun* ♑ 26° 33′ 19″.

VI. To the Place of the *Sun* thus found; with the Mean Anomaly and the True Place of the *Sun*, find the Equation of Natural Days 5′ 34″ Add. Which therefore in our Example, muſt be ſubtracted from the Mean Time laſt corrected.

	h	′	″
The Time 2 corrected, *An.* 1710. *Jan.* 5th	12	00	00
Æquation of Time ſubtract — — —		5	34
The correſponding apparent Time, *Anno* 1710, *January* 5th	11	54	26

	°	′	″
Which converted into Degrees, *&c.* is	178	36	30

VII. *To find the* Sun's *Right Aſcenſion, ſay,*

As Radius — — — — — —	10.000000
S. c. Decl. max. 23° 30′ — — —	9.962398
T. Long. ☉ - - - 63° 26′ 41″ — —	10.301199
T.c. of the *Sun*'s Right Aſcenſion 61° 24′ 00″	10.263597

	°	′	″
Therefore the *Sun*'s Right Aſcenſion is	298	36	00
To which Add the Time found §. 6. converted into Degrees and Minutes	178	36	30
The *Sum* is the Right Aſcenſion of the Meridian of *London*	117	12	30

From

	°	′	″	
From the Right Aſcenſion of *Cor Leonis*	148	08	00	
Subtract the Right Aſcenſion of the Meridian of *London*	117	12	30	
There Remains the Longit. of *Lond.* from our FIRST MERIDIAN	30	55	30	*Weſt.*
And by §. 2. the Longitude of the Place of Obſervation was found	45	55	30	*Weſt.*
Therefore by *Definition* II. the *Longitude* of the Place of Obſervation from the Merid. of *London* is	15	00	00	*Weſt.*

VIII. *To find the Time of the Obſervation.*

		d	h	′	″
From the Apparent Time found §. 6.	*An.* 1710, *Jan.*	5	11	54	26
Sub. 1 *h*. equal to the Diff. of Longitude converted into Time	- - - - - -		01	00	00
There Remains the Apparent Time of the Obſervation.	*An.* 1710. *Jan.*	5	10	54	26

Thus have we, from the Obſervation of the Altitudes of the *Moon*, and two known Fixed Stars, ſhewn, how the Latitude and Longitude of the Place of Obſervation,

tion, and the exact Time may be found; which, in our Example, are as follows,

The Latitude of the Place of Obſervation by §. 2. *is* - - - 27° 24′ 27″ *North.*

The Longitude of the Place of Obſervation from the Merid. of Lond. *by* §. 7. *is* - - - 15° 00′ 00″ *Weſt.*

The Apparent Time of the Obſervation by §. 8. *is* *An.* 1710, *Jan.* 5ᵈ 10ʰ 54′ 26″

Q. E. I.

CONSECTARY I.

HENCE the Latitudes and Longitudes of all the noted Places of the Terraqueous Globe, may eaſily be found, by any Perſons obſerving, in ſuch Places, the Altitudes of the *Moon* and any two known Fixed Stars, as is before mention'd: Or by obſerving the Altitude of the *Moon*, the Altitudes of any two known Fixed Stars, and the Vertical Angle comprehended between the *Moon* and either of the ſaid Fixed Stars. From which Obſervations they may either compute the Latitudes and Longitudes of ſuch Places from the Meridian of *London*; or tranſmit them to the *Royal Society* at *Greſham-College*, *London*; by whoſe Direction the Obſervers Names, and the proper Calculations, will be inſerted in the *Philoſophical Tranſactions*. And by ſuch Means, *Geography* may, in a few Years, be brought to Perfection.

CON-

CONSECTARY II.

Hence Expert Mariners may, at all times, That the Moon and Stars are obſervable, find the Latitude and Longitude of the place the Ship is in; and conſequently correct their vulgar Reckonings, and know certainly how far they are from their intended Port.

CONSECTARY III.

This Method may be applied to any other of the Planets or their Satellites.

Soli DEO
Sit Laus, Honos & Gloria.